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Deliberative Process in Sharing Information with Different Audiences: Eye-tracking Correlates

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Abstract

Research on conversational pragmatics demonstrates how interlocutors tailor the information they share depending on the audience. Previous research showed that, in informal contexts, speakers often provide several alternative answers, whereas in formal contexts they tend to give only a single answer; however, the psychological underpinnings of these effects remain obscure. To investigate this answer-selection process, we measured participants' eye movements in different experimentally modeled social contexts. Participants answered general-knowledge questions by providing responses with either single (one) or plural (three) alternatives. Then, a formal (job interview) or informal (conversation with friends) context was presented and participants decided either to report or withdraw their responses after considering the given social context. Growth curve analysis on the eye movements indicates that the selected response option attracted more eye movements. There was a discrepancy between the answer selection likelihood and the proportion of fixations to the corresponding option – but only in the formal context. These findings support a more elaborate decision-making processes in formal contexts. They also suggest that eye movements do not necessarily accompany the options considered in the decision-making processes.

Keywords: Conversational pragmatics, memory reporting, eye-tracking, confidence, social contexts

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Humans are social animals who, among other things, use interpersonal communication to establish and signal their relationships. As a result, it is important to investigate the processes associated with the communicational exchanges in order to gain a better understanding of how human relationships are shaped. These processes include the decisions we make about the information we want to share with others, and these decisions strongly depend on who our interlocutors may be (Ackerman & Goldsmith, 2008; Martín-Luengo, et al., 2021; Martín-Luengo, et al., 2018). Recent advances in technology allow us to obtain unbiased measures helping us understand the cognitive processes underlying these behaviours. One of the methods that has been very useful in this regard is eye-tracking. The current paper presents a study, in which we analysed eye movements accompanying the decision-making process that involved information exchanges during a conversation.

Conversational pragmatics

Most of the research on conversational pragmatics focuses on the processes related to the listener's ability to understand the message intended by the speaker (Noveck & Reboul, 2008). The opposite aspect of this interaction – *why* the speaker provides particular information and in *what amount* and manner – has received much less attention in existing research (Gibbs & Bryant, 2008; McCallum et al., 2016; Martín-Luengo et al., 2018; Der Henst et al., 2002; Vandierendonck & Van Damme, 1988). Overall, these and other studies support the validity of relevance theory in conversational pragmatics by showing that speakers provide the information they believe is important for the receiver (Wilson & Sperber, 1981; 2004) and suggesting that what the speaker shares depends on the social context in which the information

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exchange takes place. For example, the speaker will round up or down their rendition of current time if they believe that the exact time is not relevant in the conversation's context (Der Henst et al., 2002). When, however, the speaker is aware that the precise time is relevant, they tend to provide a more accurate time reading.

Requests to provide elaborate information, e.g., when answering difficult questions, increase the complexity of the task and the corresponding results. In recent research (Martín-Luengo et al., 2018), participants were asked difficult general knowledge questions, for which they had to provide either a single answer or plural (several) potential answers. Once they responded, they had to indicate whether they would prefer to submit or withdraw their answer(s) (the so-called report option) in either a formal or an informal context. The results indicated that in informal contexts, e.g., when talking with friends, participants' responses were not affected by their estimation of the accuracy of the information they were willing to provide, implying that they used relatively lenient criteria to report. Particularly, in this informal context the most reported option was the plural one, i.e., the one with several potential options (only one of which could be correct). This pattern can be explained as an attempt to offer a wider set of alternative answers to their friends by reporting all possible options which potentially might lead to figuring out the correct answer. In formal contexts, e.g., in a job interview, participants tended to equally report and withhold both types of answers, presumably in an attempt to keep the accuracy as high as possible. Furthermore, in formal contexts participants preferred to report the option with fewer alternatives when they had a reasonable level of confidence in the answer's accuracy. In essence, participants tried to maintain a certain level of accuracy by withholding questionable answers in a formal context whereas they provided more or less unrestricted information in an informal context. We can assume that this restricted behaviour in the formal context reflects participants' attempt to present themselves as

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more knowledgeable and consequently increase their chances of success (e.g., being employed). In the informal context, however, participants' lenient reporting was aimed to provide their friends with any information that could lead to finding the correct answer, even by association.

In the present research, we aimed to improve our understanding of the information exchange processes involved in conversational pragmatics by measuring interlocutors' eye gaze behaviour. In particular, we were interested in studying which were the options that participants considered for each social context, and, which other were automatically discarded once the context was revealed. A major advantage of studying eye movements with regard to decision making tasks is that it provides relatively unbiased information in relation to the associated written or spoken reports. *Response bias* occurs when participants align their answers due to social conventions or because they try to guess the experiment's aims and hypotheses and modify their answers accordingly (Furnham, 1986). Therefore, using eye movements allows researchers to avoid this bias by obtaining more objective measures.

Furthermore, the recording of eye movements is considered a reliable and chronometrically accurate approximation of the internal processes involved in conversational decision making (Holmqvist, et al., 2011). Supporting this view, Shimojo, et al. (2003) showed that, in a like-dislike task involving a choice between two images, the stimuli selected for reporting attracted more gazes than the ignored ones. These authors also found that, following an initial stage when gazes were roughly evenly distributed between the two stimuli, the eventually chosen stimulus received progressively more and longer gazes towards the final selection point – a phenomenon dubbed a "gaze-cascade effect".

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Decision making and eye-tracking

Most of eye-tracking studies of decision making have a strong visual component in terms of the type of stimuli used (e.g., Bond, et al., 2014, used diagnostic visual decision making with radiographies; McLaughlin et al. 2018, used diagnostic visual decision making with electrocardiograms; Simion & Shimojo, 2006, 2007, used different kind of pictures such us people, places, etc). These bottom-up attentional studies rely in the visual saliency of the stimuli putting the stress on the ability of the participant to distinguish one object from another visually similar one; however, attention can be also goal-driven where the visual saliency is not as relevant as the stimulus meaning (Corbetta & Shulman, 2002; Theeuwes, 2010; Orquin & Loose, 2013). Although fewer, several studies in goal-driven decision making have been implemented with the use of eye-tracking techniques (Lindner, et al., 2014; Orquin & Loose, 2013). For example, in Lindner et al. (2014) two different groups of participants answered multiple choice questions, for which participants had high or low prior knowledge. The results showed that students with high prior knowledge spent more time looking at the correct answers options, and that the number of fixations on the selected target increased as a function of preference ratings both for high and low prior knowledge group of students. These results show that the underlying mechanism of making decisions, reflected in the eye movement patterns, does not depend on the participants' knowledge. This is particularly important for the present study because, following Linder et al's findings; we used only difficult general knowledge questions as they offer a test bed that allows extrapolating to other question types of differing difficulty.

Another way to pursue these two research strands in decision-making with the use of eye-tracking measures is to address the core elements of this process: namely, personal preferences (e.g., attractive faces in Shimojo et al., 2003) or selection

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appropriateness (e.g., correct answers during an exam in Lindner et al., 2014). In both types of research, the number of fixations on the finally selected option was higher compared to discarded alternatives, suggesting that the eye-tracking measures are predictive of choice and preferences (i.e., gaze bias effect). Thus, it seems that the eye-tracker may not be able to distinguish between personal and impersonal nature of the decision-making processes since the outcome in both types of studies is similar. This, however, may be seen as an advantage in studying decision making processes in different social contexts. With regard to the two research strands discussed above, the decision making process could be considered as biased towards a knowledge-related decision in formal contexts, such as a job interview, with the ostensible goal of maximizing the final outcome. In an informal context, such as talking with friends, the decision making might have stronger grounding in personal preferences and not biased towards the response veracity. Considering the wide variety of social contexts, the lack of differences in eye-tracking data may allow for a direct comparison between decision making strategies in different social contexts. This is important because decision making may have a stronger ground in subjectively personal preferences in some social contexts compared to others.

Despite the dominant trend of using strong visual stimuli to study decision making via eye movements (Bond, et al., 2014; McLauchlin et al., 2017; Simion & Shimojo, 2006, 2007), studies like Lindner´s demonstrate that eye-tracking is also a useful tool for investigating other decision-making processes based on the attentional goal-driven processes. The current study builds on this approach.

The present research

For the purposes of further advances in this research filed with the help of eye-tracking techniques, we designed an experimental protocol using general knowledge

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questions that have been instrumental in previous, purely behavioral, research in this area. We limited our material set to include only difficult questions because such questions ensure that participants become engaged in a deeper decision-making process. These types of questions also allow measuring the strategic regulation of accuracy (Ackerman & Goldsmith, 2008). If the questions were easy, participants would mainly report them in their single version regardless of the context. Moreover, we combined two different answer modes allowing us to generalize towards the two different types of answers (see below) typically occurring during a conversation. Finally, we manipulated social context across the two different types – formal and informal – in order to analyze the resulting variability of the communicational exchanges.

In relation to the type of answer requested, we implemented in one step (see Figure 1) the combination of the *plurality option* (Luna, et al., 2011) along with the *report option* (Koriat & Goldsmith, 1994), and only the eye-tracking measures during the selection of these combined answers were the object of our analysis. Both plurality and report options are procedures used to study the informativeness-accuracy trade-off in memory reporting (Luna & Martín-Luengo, 2017; Martín-Luengo et al., 2018; Martín-Luengo et al., 2021). In case of the plurality option, participants are first requested to select or provide one candidate answer (i.e., single answer) and then to add more alternatives conforming to the plural answer. Finally, participants have to select the type of answer, single or plural, that should be counted as their final selection. In the report option the usual procedure entails the selection of one potential answer candidate and then deciding whether this alternative will be finally reported or if the answer will be left blank. In relation to the present experiment, if we had decided to use the plurality option only, we would have missed an opportunity to examine the eye-tracking correlates of decision making in the circumstances when participants may prefer to leave the question unanswered. There are some situations in which, for example, people

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may not want to be perceived as lacking knowledge or as being inaccurate, so they may decide not to provide any answer despite having one or several potential candidates. Similarly, we would not be able to examine the eye-tracking correlates of those situations, in which participants' preferred an answer with more than one alternative. Moreover, the resulting four answer possibilities via a combination of these two procedures are closer to real-life contexts compared to those using any of the described procedures alone. Therefore, we decided to combine them in order to offer participants the widest possible (but still fully controlled in counterbalanced fashion) set of answer alternatives: single report, single withhold, plural report, plural withhold. This is not the first experiment where plurality and report options are used at in one experiment (Luna & Martín-Luengo, 2017; Martín-Luengo et al., 2018), but this is the first time both tasks are used in a single step. Despite this methodological alteration, we do not expect to find any major difference in the distribution of the answers among the four options.

In relation to the social context, we adopted the definitions of informal and formal contexts from Martín-Luengo et al. (2018; see Table 1). In order to allow participants to simulate these social contexts, we characterized the informal context as a "meeting with friends" where the context is relatively relaxed; for the formal context, we used a "job interview" scenario with participants instructed that they have a good but still unclear chance of getting a job, so there was a degree of tension and uncertainty about the outcome. At the behavioral level, we expected to replicate previous findings by Martín-Luengo et al. (2018) regardless of a slight difference in the methodology used. Specifically, we expected an overall higher proportion of reported answers of any kind (single or plural) in the informal than in the formal context. We also predicted a similar proportion of single reported and plural withheld answers for the formal context. With respect to eye movements, we expected to register an initial general exploration of all options (Glaholt, & Reingold, 2011) in both scenarios, followed by an earlier

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eventual preferential focus shift towards the selected alternatives in the formal context. We hypothesised that this earlier shift in the formal context would reflect the necessity to be focused on the context that might have more "serious" consequences. That is, we expected that participants would demonstrate a degree of "alertness" related to the formal context by an earlier progression from a general consideration of all possible answers to the options that could maximize their success. Conversely, we expected that the same progression will be delayed in the informal context due to its more "relaxed" nature. Finally, based on the gaze-bias effect (Shimojo et al., 2003), we expected that the options selected more frequently in each of the two scenarios would be the ones with a higher fixation proportion, especially during the time nearer to making the final selection.

Method

Participants and Design

Thirty-one volunteers (25 females, mean age = 23 years old, SD = 3.05) participated in this experiment for a small monetary compensation (250 roubles, ~ 3.55 USD). The sample size was calculated based on Luna et al. (2011, Exp.1.), the first study using the plurality-option and the effect size to investigate differences in accuracy between single reported and withheld answers, the most relevant measure showing the regulation of the accuracy in memory reporting when no social context is indicated. Our power analysis with alpha-level set at .05 and power at .80 showed that a sample of 6 participants would suffice to reach a similar effect size of d = 1.37.

Materials

Forty general knowledge questions were adopted from Martín-Luengo et al. (2018). Answer alternatives were not provided, and participants had to type the answers for each question. According to the study protocol, participants first provided a *single*

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answer and then they added two more alternatives for the same question, *plural* answer. In order to establish formal and informal conversational contexts, two grayscale pictures were used (see Figure 1 panel B). To provide the formal context ("job interview"), the corresponding picture portrayed three people at an office desk – with neutral facial expressions and dressed formally. A picture portraying three people talking and laughing and dressed in informal clothes was used to support the informal context ("talking with friends") (see Appendix). The size of both pictures was 768×468 pixels. The contexts were randomized in such a way that the same question could appear in the formal context to one participant and with the informal context to another participant.

Procedure

Each participant completed their experimental session individually. See Figure 1, panel A for a graphical representation of an experimental trial. First, participants were presented with one question, and they were requested to provide a single answer and to rate their confidence in the answer's correctness. Next, participants were requested to add two more potential answers to the already provided one and to rate their confidence in these new answers as well. Following this, a fixation cross appeared in the center of the screen followed by the social context prime picture, which was presented centrally. Participants previewed the picture for 3 seconds in order to familiarize themselves with it. Finally, the four options – single report, single withheld, plural report, plural withheld – appeared beside the context picture, presented pseudorandomly in the four corners of the screen, and participants had to choose one of them.

Apparatus

The experiment was programmed in SR Research Experiment Builder v2 (SR Research Ltd, Ottawa, Canada) and run on an EyeLink 1000 desk-mounted setup. The stimuli were presented on a 24-inch monitor with a refresh rate of 144 Hz. We recorded the dominant eye only – determined by using a thumb test: participant is requested to

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superimpose their thumb on a distant object, focus on it, and close their eyes individually. The dominant eye is the one which visual field less shifted. Participants head's position was controlled using a chin rest.

Eye-movement data preprocessing and analyses

Our choice of the specific eye-tracking measures was determined by our primary interest in the period prior to making the final choice of the response option. To this end, we identified the interest period as 1800 ms preceding the timepoint when participants made their final choice by a mouse click on the selected option. This period was subdivided into 90-time bins of 20 ms length each. To analyse the time course of the eye behaviour preceding the answer selection, we computed multilevel regression or growth curve analysis (GCA) on the number of fixations on each of the four answer alternatives prior to the selection. GCA allows repeated measure observations in longitudinal data while avoiding statistical problems associated with multiple t-tests comparing performance in each time bin over the curves. GCA belongs to the family of multilevel techniques that use orthogonal polynomials to model the time course of events across multiple stimuli. In our case, these stimuli were the four answer options (see Figure 2 panel B). This type of analysis has been extensively used in psychological research (McArdle & Nesselroade, 2003), including the analysis of eye-tracking data with the objective to conduct a longitudinal repeated measures analysis (Mirman, 2014; Mirman, et al., 2008)[1].

Fixed-effects condition was the type of answer (single reported, single rejected, plural reported, plural rejected) on all time terms. Participants and participant-by-condition random effects were used on all time terms. The single reported option was treated as the reference (baseline) condition. Normal approximation (i.e., treating t-

[1]For a detailed explanation of the growth curve models, applications to eye-tracking analysis and R syntax to conduct them, check the Github page of Daniel Mirman's lab https://dmirman.github.io/

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value as z-values) was used for the individual parameters' statistical significance (p-values). Linear, quadratic, and cubic terms were computed to assess the shape of the curves.

Results

Behavioral results summary (for full report, see Supplemental Materials)

See Figure 2, panel A, for the graphical representation of the proportion of selections of each of the four alternatives (single report, single withhold, plural report, plural withhold) by social context. We computed t-test comparisons and not ANOVAs in order to avoid a collinearity violation, because the options in the report and plurality option procedures are linear transformations of each other (Luna & Martín-Luengo, 2017; Luna, et. al, 2015; Martín-Luengo et al., 2018; Martín-Luengo et al., 2021): If an answer was selected as a single option, it could not be simultaneously selected as a plural option; similarly, if marked as a report option, it could not be selected as a withhold option.

Full results with respective statistics are presented in Supplemental Materials and summarised here. Overall, our results replicated those reported previously in Martín-Luengo et al. (2018). Specifically, there were more reported answers in the informal than in the formal context. In the formal context, there were more single reported than single withheld answers, and similar numbers of plural withheld and plural reported answers. In the informal context, reporting options, both in the single and in the plural response conditions were selected more often than withholding ones. Also in this context, the most frequent answer was plural report. These results support the differential pattern of answers depending on the social context.

In general, therefore, our behavioural results support the notion that, at the same level of knowledge, respondents select their report strategies taking their audience into

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consideration. In particular, these results support the idea that in a job interview we will try to show ourselves as knowledgeable as possible by mainly selecting single report answers, while in the informal context it is preferred to help to find out the answer by selecting the plural report alternative.

Eye movements

Prior to the analyses of the eye fixations, we ran a 2 Social context (formal, informal) X 2 Report option (report, withhold) X 2 Plurality option (single, plural) on the averaged total fixation time (see Figure 3). No main effects or interactions reached significant differences (for Social context, $F(1, 30) = 0.282$, $p = .603$, $\eta_p^2 = 0.018$; Report option, $F(1,30) = 0.917$, $p = .353$, $\eta_p^2 = 0.058$; Plurality option, $F(1, 30) = 2.954$, $p = .106$, $\eta_p^2 = 0.165$; Social context*Report option, $F(1, 30) = 0.010$, $p = .920$, $\eta_p^2 = 0.000$; Social context*Report option, $F(1, 30) = 1.170$, $p = .297$, $\eta_p^2 = 0.072$; Plurality option *Report option, $F(1, 30) = 1.345$, $p = .264$, $\eta_p^2 = 0.082$; Social context*Plurality option*Report option, $F(1, 30) = 0.141$, $p = .713$, $\eta_p^2 = 0.009$). This lack of differences in the total time spent on each of the possible alternatives likely indicates that fixations were longer on those alternatives with fewer fixations and shorter for those alternatives that attracted a larger number of fixations.

Eye movements – Growth curve analyses

Analyses were performed using the lme4 R package, version 3.4.0. The code and the growth curve analysis output can be found at the Supplemental Materials. Figure 2, panel B, shows that the overall time course for target fixations was captured by a third-order (cubic) orthogonal polynomial term. We included linear, quadratic, and cubic terms in order to cover three curve changes (see Figure 2 panel B) that our data reveal: initial change from flatness, early increase for fixation, and change of direction to plateau. The interpretation of the significances in relations to the terms was performed as follows: the intercept (0th order) was a constant difference, the linear (1st order) term

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related to a single change of focus, the angle of the curve; the quadratic (2nd order) terms relates to two changes from the focus, the central inflexion of the curve; and the cubic (3rd order) term also indicated inflexions of the curve but at the extremities (Kalénine, et al., 2012; Mirman, et al., 2008).

Informal context. There was a significant main effect on the intercept for single withheld (Estimate = -0.0367, *SE* = 0.0080, $p < .001$) and plural withheld answers (Estimate = -0.0227, *SE* = 0.0080, $p = .004$), but only marginally significant effect for plural reported (Estimate = -0.0153, *SE* = 0.0080, $p = .056$). That is, single report answers received a proportion of fixations similar to that for the plural report option, but more fixations than the single and plural withheld options.

There were also differences in the linear term between single reported and plural withheld answers (Estimate = -0.1137, *SE* = 0.0565, $p = .042$) as well as both linear and cubic differences between single reported and withheld answers (for linear, Estimate = -0.278, *SE* = 0.056, $p < .001$; for cubic, Estimate = 0.091, *SE* = 0.0257, $p < .001$). This result indicates that both single and plural withheld option fixation patterns were different from the single reported option in the inflections, that is, with one change in directionality. In the case of the single withheld answers, this also occurred at an earlier time. This pattern may be interpreted as if these two options were quickly disregarded in the consideration as options in favour of the subsequently reported ones.

Formal context. There was a significant main effect on the intercept for single withheld (Estimate = -0.041, *SE* = 0.008, $p < .001$) and plural reported answers (Estimate = -0.037, *SE* = 0.008, $p < .001$), but not for plural withheld ones (Estimate = -0.013, *SE* = 0.008, $p = .127$). These differences indicate that, overall, there was a higher percentage of fixations towards single reported answers than towards single withheld or plural reported answers. These differences indicate that the two competing options were single reported and plural withheld in this context.

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There were also differences in the linear (Estimate = -0.274, *SE* = 0.060, *p* < .001) and the cubic (Estimate = 0.066, *SE* = 0.023, *p* = .005) terms for the single withheld answers, and in the linear (Estimate = -0.242, *SE* = 0.060, *p* < .001) and cubic term (Estimate = 0.056, *SE* = 0.023, *p* = .018) for the plural reported answers. As in the formal context, this early change in the directionality of the curves could be interpreted as an early disregard of these two options, though in some cases they were finally selected.

Discussion

Attention plays an active and important role in decision making (Orquin & Loose, 2003). Most of the research on decision making with the use of eye-tracking has been focused on the top-down attention component (Bond, et al, 2014; McLaughlin et al. 2018; Simion & Shimojo, 2006, 2007). However, eye-tracking has proven to be equally useful in goal-driven research in decision making (Lindner et al., 2014) as is also the case here. In particular, we used it here to further understand conversational pragmatics from the speaker's point of view. To that aim, participants answered general knowledge questions and later were requested to decide whether they would report or withhold a full or a short answer in different social contexts (formal or informal). At behavioural level our results replicated previous research (Martín-Luengo et al. 2018) and align well with the relevance theory which states that speakers tend to provide the information they believe is important for the receiver (Wilson & Sperber, 1981; 2004). The use of eye-tracking allowed us to assess whether the most selected options in formal and informal contexts at the behavioral level were the options with more gaze fixations, as suggested by earlier research that provides evidence in favor of the gaze bias effect (i.e., Shimojo et al., 2003; Lindner et al., 2014). Overall, this expectation was confirmed as we found that the most preferred options in each context were those with

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more gaze fixations. However, the remaining options were not equal in terms of attracting participants' attention. This is a novel result suggesting that the more fixated options are not always the ones finally selected in conversational pragmatics decision making tasks.

Do the final selection options attract more attention prior to decision?

Informal context. In this context both report options, single and plural were most frequent, with the plural report option selected more often than the single report option (Martín-Luengo et al., 2018). The withheld options were barely selected. Also in this context, gaze fixation results parallel the pattern observed in the behavioral data. This fact reflects that participants were willing to report any answer as there was little stress or urgency to appear as experts on the topic. Considering these behavioral and eye-tracking data together, it can be concluded that participants treated single and plural report options as equally appealing, but, since the plural choice has more chances of including the correct alternative, they preferentially selected that one. Even if no plural option alternative is correct, this still allows narrowing down the search for a correct answer. In short, in the informal context both behavioral and eye-fixations results converge in the same conclusion: participants would try to offer most complete information to their friends.

Formal context. As Figure 2A illustrates, the single report was selected more often in the formal context, reflecting participants' tendency to opt for a more common and acceptable answer in this context, in line with previous behavioral results (Martín-Luengo et al., 2018). After the selection of a single report, participants equally selected any of the plural options as a way to control the accuracy, since plural options are the ones with more chances of being correct. However, if we consider the proportions of fixations on each of the four answer alternatives, we may see a slightly different pattern. We found no differences between single and plural withheld options in the proportion of

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fixations in this formal context, and there were significantly more fixations for the single reported than for single withheld and plural reported options. This pattern supports the notion that the options that receive more attention prior to the final decision-making point are the ones which a selected more often, but that there also seem to be cases in which an option does not necessarily need to attract many fixations before it is selected, as we found in the case of the plural report alternative. This divergence between behavioral and eye-tracking data may result from the specific properties of the formal context used, i.e., job interview. A job interview contextualizes a general aim of a knowledge-based behavior with strife for answer veracity and a positive objective outcome. However, this is also a social situation where subjective preferences and social expectations are common, e.g., not leaving any questions unanswered. Thus, a more complex situation, not solely based on the interviewee's knowledge or subjective preferences may lead to a different oculomotor behavior pattern.

How can we explain that the plural reported answers were less fixated but still equally selected along with the single report? Single reported answers are the natural type of answer to any question, but they are also the preferred option in this particular communicative context because they demonstrate certain knowledge (Ackerman & Goldsmith, 2008; Martín-Luengo et al., 2018). Notably, the use of difficult questions in this experiment makes the plural withheld option the safest choice: the accuracy remains as high as possible, because there are more chances that the correct answer was included among the different alternatives. However, while the single report option is acceptable albeit riskier and the plural withhold option is safe but unacceptable (it would mean to provide no answer), the option that would compromise between these alternatives is the plural report: it includes all alternatives and thus has a higher chance of being correct, it implies certain knowledge on the topic, and it does provide an answer. The participants may have therefore mainly considered either single report or plural withheld, but

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sometimes, possibly randomly and impulsively, participants tried to compensate the accuracy by selecting the plural report answers.

The fact that one of the less fixated options was also the one more frequently selected is contrary to what gaze "cascade-effect" framework suggests but it is well aligned with other results in the literature (Orquin & Loose, 2013). In their review, Orquin and Loose showed that the process of decision-making and its eye-movement correlates depend on different factors including the cognitive processes involved that will vary depending on the particular experimental task. Some experiments primarily rely on the working memory processes; others – on the processes of attention (e.g., top-down, bottom-up). Thus, one needs to consider the particular task and stimuli the experiment used, and because of that, some of the results might not be aligned with the previous literature findings. This is what seems to happen when we try to fit our results in the formal context for the less selected alternatives. Further research would be necessary to confirm these novel findings.

Finally, it is also worth mentioning that, despite differences in the proportion of fixations to the different answer types, the average fixation duration did not differ. Duration difference have previously been linked to preferences – the longer the fixation, the higher the preference for the stimulus (Glaholt, et al., 2009; Maughan, et al., 2007). In the present study we did not register a similar pattern. This discrepancy might be due to the nature of the stimuli, visual vs. semantic in our case, and it opens a new avenue for the research regarding the divergences of gaze bias depending on the type of stimuli.

Implications

This research contributes to the plethora of studies that employ eye-tracking measurements to investigate decision-making process (Aryadoust, 2019; Emhardt et al., 2020; Lindner et al., 2014). Here we have shown that it is also a very useful tool to investigate in an unbiased fashion the underlying decision-making processes occurring

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in communication exchanges. The use of self-reports about the decision can be biased by the participants and blur the results. With the use of eye-tracking we remove any bias from the results, and by its combination with behavioral measures we can have a closer access to the nature of participant's behavior during a conversation.

In the particular case of this research we can reinforce the idea that people develop a strategic use of their options in different social contexts (Ackerman & Goldsmith, 2008; Martín-Luengo et al., 2018). In the formal context participants employed a strategy aimed at conveying the most positive image of themselves to potentials employers, and in the case of the informal context, talking with friends, they tried to maximize the chances of giving the correct answer. Although more research is needed in this regard, we can tentatively conclude that the decision-making process is more complex in formal than in informal contexts. This information is crucial to develop and complement theories about the pragmatics in conversations, particularly considering the speaker's point of view. The pragmatics of the speaker's side of the conversation has been less studied in the past and more research is needed in order to have a complete picture about how and what variables affect social interactions.

Limitations & future research

Despite the obvious usefulness of eye-tracking technique for studies like the one presented here, it also has its limitations. It is not an invasive technique and is entirely safe, but using high-resolution eye-tracking with head fixed on a chin rest makes the laboratory set-up more distant from that of a natural conversation. Future research on this topic might consider using portable or wearable eye-trackers which could make the experimental settings more ecological.

Another limitation of this study is the number of contexts used. We decided to use only two contexts to avoid the reduction of variance and to maximize potential differences between the two contexts, for a clearer result. This makes our conclusions

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restricted to these two particular situations and not to all formal and informal contexts. For example, testifying in a court is a formal context in which in most of the countries it is compulsory to declare any type of information related to the matter judged. In that particular case, a decision to withhold an answer to avoid being incorrect or to try to show ourselves as knowledgeable is not an option.

Finally, for the type of general knowledge questions we used, it is not possible to investigate whether participants would vary their lexicon depending on the social context. For example, in a question like "What is the name of the insect that glows at night?" participants could decide to answer "lightning bug" when questioned by friends or in an informal context, whereas it is more likely that they would decide to answer ¨firefly" in a formal context. This is a very interesting venue for future research where eye-tracking measures may potentially offer very valuable information.

In sum, several things will need to be considered in follow-up studies in order to overcome these limitations. That notwithstanding, the current experiment is the first one to study conversational pragmatics from the speaker point of view with the use of eye-tracking, which opens an exciting avenue for further research in the future.

Compliance with Ethical Standards

Funding: This article is an output of a research project implemented as part of the Basic Research Program at the National Research University Higher School of Economics (HSE University). This study used the HSE Synchronous Eye-tracking, Brain Signal Recording and Non-Invasive Brain Stimulation System.

Data accessibility: materials and data are available upon request from the first author.

Conflict of interest: none of the authors have conflict of interest.

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Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This work received the approval of the HSE ethics committee.

Supplementary Material

The Supplementary Material is available at: qjep.sagepub.com

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Figure Captions

Figure 1A and 1B. Panel 1A: experimental procedure used on each trial. Analysis of eye-tracking correlates are based only on the step 5 data: combined plurality-report options decision. Panel 1B: the two pictures used to illustrate the two social contexts.

Figure 2. Panel 2A: Proportion of selected answer by context and answer type. The bars in the columns indicate the standard errors. **Panel 2B:** growth curves on the proportion of fixations on each of the four alternatives of answers for each social context. The intercept is located on the right side. The x-axis shows the time from -1800 prior to the decision until 0 ms when the participants click the mouse to make their selection. In both panels the data corresponding to the formal context appears on the left and on the right for the informal context. The black solid line at the -1350 ms in the formal context panel indicates the particular time in which the gaze starts to be distributed among the options. Note that, in the informal context panel, this time point is delayed and closer to the -900 ms.

Figure 3. Averaged total fixations times and standard errors (in milliseconds) for each of the four answer alternatives for each social context.

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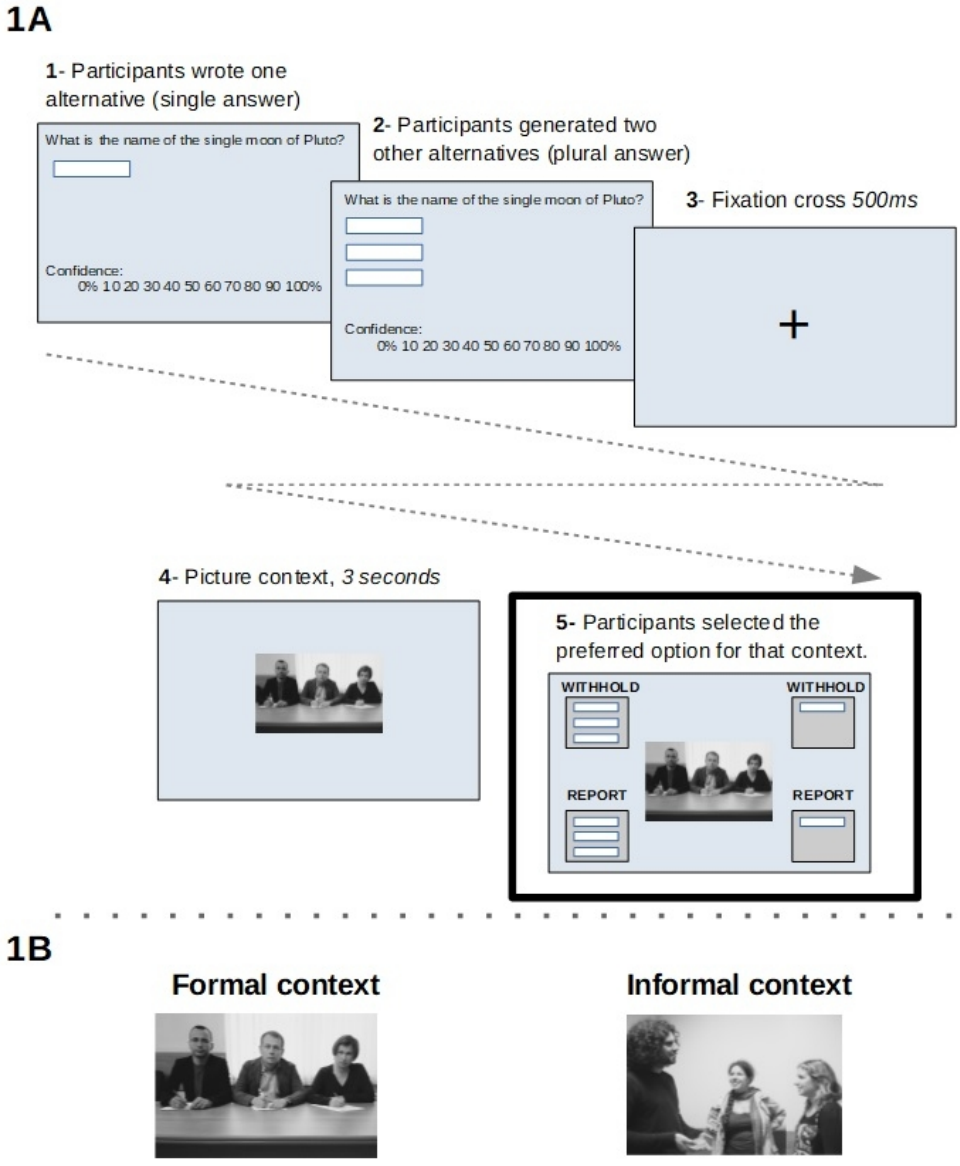

Figure 1A and 1B. Panel 1A: experimental procedure used on each trial. Analysis of eye-tracking correlates are based only on the step 5 data: combined plurality-report options decision. Panel 1B: the two pictures used to illustrate the two social contexts.

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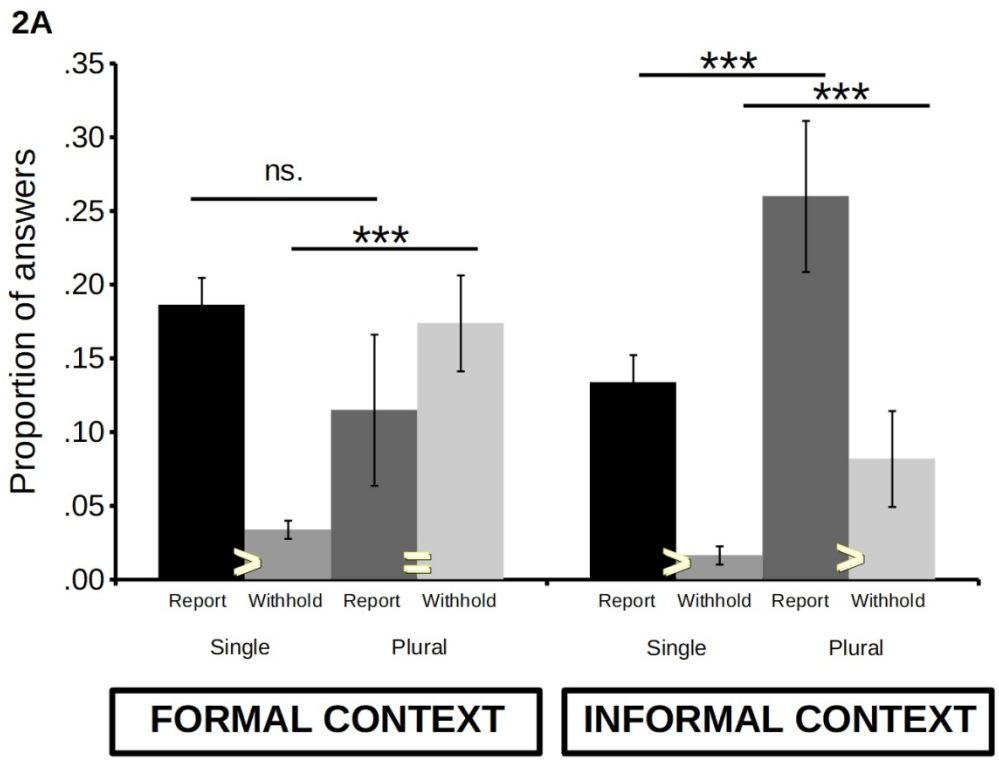

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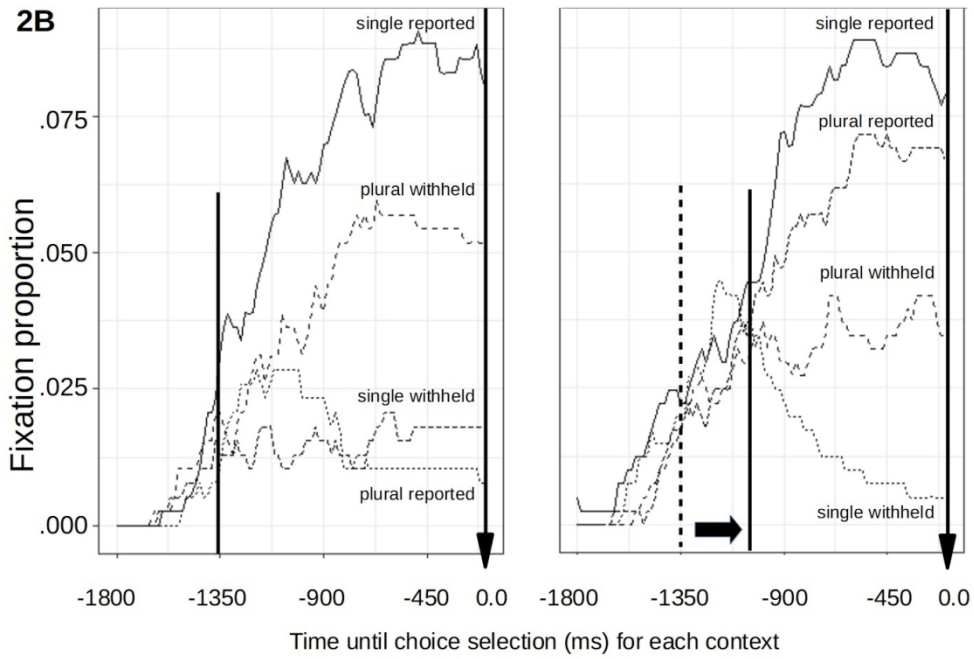

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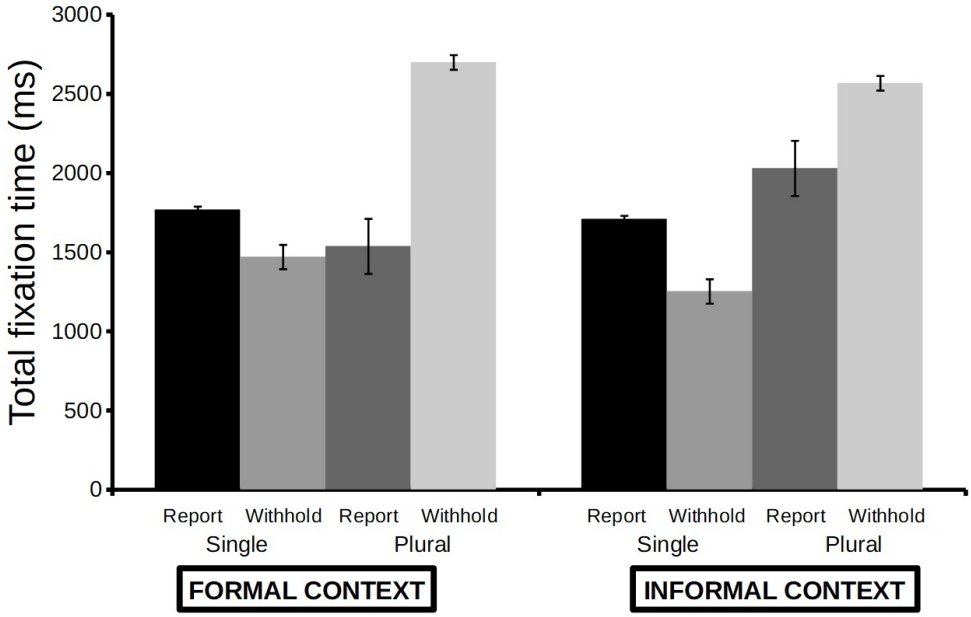

Figure 3. Averaged total fixations times and standard errors (in milliseconds) for each of the four answer alternatives for each social context.

271x184mm (120 x 120 DPI)

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Table 1. English translation of the Descriptions for Each Condition.

Formal context	Job Interview	Imagine that you are in an important job interview. You really need this job. You feel the tension, but you still try to look like an expert in the field.
Informal context	Conversation with friends	Imagine that you are with friends, having a good time. You feel relaxed and glad to be with them. You are having a cheerful conversation about different topics.

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